



MANUAL OF LAPAROSCOPIC SURGERY

First Edition

EDITORS

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Our Mission:

*to promote and coordinate
minimally invasive and endoscopic
surgery in multiple surgical
disciplines, to provide outstanding
care and service for patients and
to have leadership in clinical,
educational and research
programs in advanced minimally
invasive surgery through the
application of new and innovative
technologies.*



*If you are thinking one year ahead, you plant rice.
If you are thinking twenty years ahead, you plant trees.
If you are thinking a hundred years ahead,
you educate people.*

Chinese proverb



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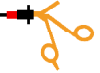
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FOREWORD

Diagnostic Laparoscopy was being practiced in Singapore in the late 1960s (Professor K. T. Chan) with limited instrumentation then available. Laparoscopic activity has had a significant impact in Obstetric and Gynaecology ever since the stimulating visit of Kurt Semm in the 1970s. In Orthopaedic Surgery new horizons have been opened up with minimal access to joints and the spine. However, since the first laparoscopic cholecystectomy in Singapore (1990, M. Chellappa), the phenomenon of minimal access to the abdominal cavity (including retroperitoneum and thorax) has radically changed our approach and practice, and most importantly training of the abdominal surgeon.

It is now mandatory for the surgical trainee (basic and advanced) to be completely familiar with all aspects of access, surgical procedure, camera technique, intra-abdominal gases and pressures, etc., but the surgeon must also understand the principles and fundamental workings of the hardware support systems. As technology is being continuously updated it will be necessary for all to keep abreast of these advances.

The aim of this manual is to lay down the basics of the minimal access approach for the neophyte, advanced surgical trainee and the practicing surgeon. It is hoped that it will also benefit the operating theatre staff to understand the rationale of Minimally Access Surgery (MAS). Lastly, it is the intention of this manual to disseminate the benefits of MAS and establish training standards at various levels by continued update of current information as it becomes available.

Professor Abu Rauff



PREFACE

In almost a century surgery, few advances can be compared to the changes engendered by the introduction of minimally invasive surgery, representing in the last decade a revolution in surgical practice and patient care. Since 1987, when the first laparoscopic cholecystectomy was performed, laparoscopic procedures have been the standard of care for many routine diagnostic and therapeutic procedures for conditions such as appendicitis, gallstones, hernia, hyperhidrosis, gastro-esophageal reflux, etc. The success of the laparoscopic technique has been due mainly to patient demand, which has contributed to a rapid expansion in the number of laparoscopic procedures performed. Today, more than 90 % of cholecystectomies are performed laparoscopically, and the approach has been adapted successfully for other surgeries of the abdomen, thorax, and vascular system. The benefits conferred to patients by less invasive procedures, decreased pain, and shorter recovery have to be weighed against overenthusiasm of application and the problems created by a lack of familiarity with new techniques and instruments.

The laparoscopic revolution brings also new concepts of training and gaining experience along the learning curve. And with technological advancements, a new frontier in training program is started. Practice with; hands-on-training, video-tape reviewing, operating on live tissue- all these have been basic activities in the training program. Today, technology has added the use interactive CD- Rom, suturing and training of different tasks with laparoscopic virtual simulator, and E-learning softwares, for similar tasks. These tools are, mandatory and necessary in current ~~all~~ training centres to enforce the skills needed for both basic and advanced procedural training. But of course, all these activities must complement also an active clinical practice.

The decision to write this Manual is mainly to provide to trainees a Compendium of core information and knowledge, and also pearls and tips to improve their surgical skills.

This Manual has been an effort of MISC team members and is organized into three main sections: general laparoscopic principles, anaesthesia in laparoscopic surgery, and basic laparoscopic procedures. In general principles, the characteristics and functions of all instruments and devices

are analyzed; in the second section, the role of anaesthesia and the anaesthetic implications during laparoscopic surgery are described; while in the final section, the authors describe how to safely enter the abdominal cavity, laparoscopic suturing, and step-by-step basic laparoscopic procedures.

We would like to extend our sincere appreciation to all the authors for their contributions, our secretary who has been helpful throughout the editorial process, and our families for their ~~her~~ continuous support.

*Davide Lomanto,
Cheah Wei-Keat*



INTRODUCTION

Cheah Wei Keat

EVOLUTION OF LAPAROSCOPIC SURGERY

The historical development of laparoscopy can be traced back to 1901 when George Killing of Germany inserted a cystoscope into the abdomen of a living dog after creating a pneumoperitoneum using air. A century ahead, we are now more technical and technological. With the culmination of technological advances, laparoscopic surgery is ingrained in our surgical practice and we are able to perform diverse and complex laparoscopic procedures, also termed minimally invasive surgery.

Laparoscopic surgery is defined by its three main components of image production (light source, laparoscope or rod lens system, and camera), pneumoperitoneum- the insufflation of carbon dioxide gas to create space for operation, and laparoscopic instruments. With this combination, surgeons could perform diagnostic and some basic gynaecological procedures since the 1960's.

However, a major revolutionary shift in surgical practice and thinking came in 1988 when Mouret of France performed the first laparoscopic cholecystectomy. Instead of removing the gallbladder through a Kocher's incision, he did it through a few small wounds each not larger than 1 cm. This exciting concept sparked intense developments in instrumentation, innovation in advanced technical procedures, proliferation of training programs, and setting-up of laparoscopic centres. We are indeed in an era of modern surgery.

Laparoscopic surgery and traditional open surgery is likely to co-exist together. It is part of the repertoire a young surgeon in training should develop skills in. This brings us back to the objectives of this manual- for training development and safety in practice.



WHY SHOULD WE DO LAPAROSCOPIC SURGERY?

The answer is simple: because patients *can and do* benefit from it. As long as the evidence suggests- and there is ample data by now- that laparoscopy has its benefits, it can be justified to be performed in various procedures. Laparoscopic cholecystectomy has replaced the traditional open approach to non-complicated gallbladder disease as the new gold standard because it results in less postoperative pain, less postoperative pulmonary dysfunction, faster return of bowel function, shorter length of hospital stay, faster return to normal activities and work, and greater patient satisfaction. These benefits also generally extend to other laparoscopic procedures.

The advantages mentioned above result from the most obvious difference between laparoscopic and open surgery- that of less surgical trauma to the wound in laparoscopy. The access scar is minimized, leading to less pain, less wound infection and dehiscence, and better cosmetic result. In addition, laparoscopy also reduces tissue trauma during dissection, and subsequent blood loss, reduces systemic and immune response, and reduces adhesive complications.

From the surgeon's point of view, the projected image on the monitor is a magnified image, resulting in better definition of structures. It's faster to close smaller wounds. And the recorded procedure can be used for review and training purposes.

As in all surgical techniques and technologies, minimally invasive surgery also has its limitations and disadvantages. First, there may be problems encountered during access into the abdominal cavity, such as iatrogenic injuries to the bowel or major vascular structures. The incidence is about 0.05 to 0.1%. This incidence is reduced by practicing the open technique of introduction, rather than using the "blind" Veress needle technique, and using blunt-tipped trocars. Second, there may be undesirable side-effects of the carbon-dioxide pneumoperitoneum, such as hypercarbia, etc (see chapter on physiology of pneumoperitoneum). And third, from the surgeon's perspective, the migration from open to laparoscopic skills means



that the 3D vision is reduced to monocular 2D vision on the screen, depth perception and field of view is much reduced, and haptics, or the “feel” and tactile sensation of tissues, is limited to gross probing of tissues. However, these limitations, once understood and overcome have not hampered the development of laparoscopy.

In a way, the surgeon is required to master a new set of skills to perform laparoscopy safely. With training and experience, surgery can be performed at a new standard that benefits patients.

IS WHICH TYPES OF SURGERY IS LAPAROSCOPY APPLICABLE?

Laparoscopy can now be performed in three main areas of the body- the abdomen, the thorax, and closed spaces. Laparoscopy can be used to resect tissues or to reconstruct tissues.

In the abdomen, we group laparoscopic techniques according to major systems, as shown below.

a) Gastrointestinal tract

- Laparoscopic-assisted oesophagectomy
- Laparoscopic cardiomyotomy for achalasia
- Laparoscopic fundoplication for gastro-oesophageal reflux disease
- Laparoscopic bariatric surgery (banding, bypass) for morbid obesity
- Laparoscopic gastrectomy and small bowel procedures
- Laparoscopic appendicectomy
- Laparoscopic colectomy
- Laparoscopic adhesiolysis and diagnostic laparoscopy

b) Hepato-biliary-pancreatic system

- Laparoscopic cholecystectomy
- Laparoscopic liver and bile duct procedures
- Laparoscopic management of pseudocysts and pancreatic procedures



- Laparoscopic bypass procedures
- Laparoscopic splenectomy

c) Endocrine system

- Laparoscopic adrenalectomy
- Laparoscopic enucleation of benign pancreatic islet tumours
- Endoscopic Neck Surgery

d) Abdominal Wall

- Laparoscopic inguinal hernia repair
- Laparoscopic repair of incisional hernia

e) Urologic system

- Laparoscopic nephrectomy
- Laparoscopic procedures for ureteric and bladder conditions

f) Gynecology

- Laparoscopic management of tubo-ovarian conditions
- Laparoscopic hysterectomy

In the thorax, some procedures include,

- Thoracoscopic sympathectomy for palmar hyperhidrosis
- Thoracoscopic pleurodesis
- Thoracoscopic bullectomy and partial lobectomy

With the use of novel devices, adequate operating space can be created in “closed” spaces so that endoscopic techniques can be performed, such as,

- Endoscopic extraperitoneal inguinal hernia repair
- Endoscopic ligation of saphenous venous perforators in the leg
- Endoscopic approach to neck organ such as the thyroid and parathyroid glands



One can see that laparoscopy is widely applied. It's important, however, to realize that for certain conditions, laparoscopy is feasible but does not necessarily replace open techniques. The practice will depend on the expertise available and also on literature evidence that laparoscopy is superior to the open approach.

TRAINING ISSUES

Surgical training is the core reason for the conception of this training manual. Surgeons in training are taught well established skills in open surgery. However, learning of laparoscopic skills is now becoming an increasingly important part of the training program because of the new set of skills that need to be acquired. The main focus is to operate efficiently and minimize surgical errors, i.e. operate safely. Training and constant practice are ways to overcome the learning curve. A case point is the dramatic increase by three to five fold in bile duct injuries in the early years when laparoscopic cholecystectomy was performed by inexperienced and poorly trained surgeons; the rate has since dropped to acceptable levels.

Effective teaching and learning involves dedicated staff with experience in laparoscopic surgery who are good educators and enthusiastic students who are keen to acquire new knowledge and skills. This is facilitated by modern teaching instruments such as laparoscopic trainers, virtual simulators, CD-ROMs, the Internet, and software programs, all available in the in-house skills lab in the Minimally Invasive Surgical Centre (MISC). In addition to these activities, meetings and workshops all contribute to CME activities.

Training programs comprise of two broad categories- Basic and Advanced Laparoscopic skills. In the basic program, the student is taught about familiarization with equipment and instruments, physiology of pneumoperitoneum, access and port placements, diathermy and dissection techniques, and safety issues. This is extended in the advanced program to suturing skills, use of instruments in advanced techniques, and familiarization with advanced procedures. The training program at the MISC,

NUH runs twice yearly. Each course has four modules that total 12 hours of training.

THE FUTURE OF MINIMALLY INVASIVE SURGERY

Minimally invasive surgery, as it stands today, has been the result of intense and continuous development and innovation on the part of surgeons in techniques, private industries in instrumentation, and in no small part by public demands and patient requests. Surgical innovation will and should continue, however, while maintaining a balance of not escalating costs of healthcare delivery.

The progress of MIS will mirror that of developments in instrumentation, because technical innovation and expansion into previously “difficult” territories and advanced procedures has reached a plateau. With better and newer instruments, procedures can be performed faster and more effectively, with the potential of reducing operating duration and overall costs.

With progress in information technology (IT), mass data can be exchanged faster along the Internet and ISDN lines, thus enabling more use of teletransmission and teleproctoring to remote areas. Robotic devices have been developed to assist in surgery and may one day also allow surgeons to operate from remote locations. And interconnectivity of information will streamline the process of surgery.

In conclusion, laparoscopy is a marriage of surgical skills, surgical innovation, and technology advancements. Training is at the core of improving the performance of surgeons so that patients benefit from the high quality of care given to them.



LAPAROSCOPIC SURGERY: TECHNICAL CONSIDERATIONS

Shridhar Iyer, Davide Lomanto

OPERATING ROOM SET-UP:

The proper hardware and instruments are essential for performing a safe laparoscopy. Most large medical centers have one or several dedicated interventional laparoscopic operating rooms. There should be a sufficient back up of instrumentation to cover for equipment failure. Using an electric or powered operating room table is a definite asset. In most cases, the surgeon has to frequently change the position of the patient in order to enhance exposure and visualization. If performing laparoscopic bariatric procedures, the weight limit of the operating room table should be checked. Computer-ready-connected operating table are a must if the surgical team uses a surgical robot. In addition facilities for intra-operative imaging should be available.

LAPAROSCOPIC INSTRUMENTATION

1. Optical Devices
2. Equipment for creating / maintaining domain
3. Instruments for Access
4. Operative instruments
5. Energy sources
6. Tissue approximation/ hemostasis
7. Miscellaneous

1. Optical Devices

Telescope: This endoscope is made of surgical stainless steel containing an optical lens train comprised of precisely aligned glass lenses and spacers (Rod lens system). It comprises of the objective lens, which is located at the distal tip of the rigid endoscope, which determines the viewing angle. The light post at right angles to the shaft, allows attachment of the light cable



Figure 1



Figure 2

to the telescope. The eyepiece, or ocular lens, remains outside of the patient's body and attaches to a camera to view the images on a video monitor. Telescopes or laparoscopes come in various sizes 10mm (figure 1), 5mm, 2-3mm 'needlescopes' (figure 2) and with various visualization capabilities such as zero degree forward viewing, 30 or 45 degree telescope (figure 3), zero degree telescope with 6mm instrument channel (operating laparoscope).

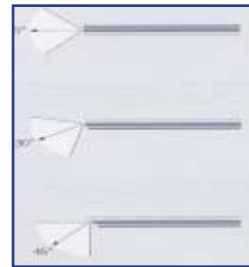


Figure 3



Figure 4

Light source: White light illumination is provided from a high-intensity xenon, mercury, or halogen lamp and delivered via a fiber-optic bundle. (figure 4)

Light cable: Light is transmitted from the lamp to the laparoscope through cables. There are two types of cables: fiberoptic and fluid. Fiberoptic cables (figure 5) are flexible but do not transmit a precise light spectrum. Fluid cables transmit more light and a complete spectrum but are more rigid. Fluid cables require soaking for sterilization and cannot be gas sterilized.



Figure 5

Video Camera: The basis of laparoscopic cameras is the solid-state silicon computer chip or CCD (charge-coupled device).



This essentially functions as an electronic retina and consists of an array of light-sensitive silicon elements. Silicon emits an electrical charge when exposed to light. These charges can be amplified, transmitted, displayed, and recorded. Each silicon element contributes one unit (referred to as a pixel) to the total image. The resolution or clarity of the image depends upon the number of pixels or light receptors on the chip. Standard cameras in laparoscopic use contain 250,000 to 380,000 pixels. The single chip camera has a composite transmission in which three colours, red, blue and green, are compressed on a single chip. The three-chip camera (figure 6) has a separate chip for each colour with a higher resolution. The clarity of the image eventually displayed or recorded will also depend on the resolution capability of the monitor and the recording medium. Standard consumer-grade video monitors have 350 lines of horizontal resolution; monitors with about 700 lines are preferred for laparoscopic surgery.



Figure 6

Television Monitor: High-resolution video monitors are required for suitable reproduction of endoscopic image (figure 7). In general the resolution capability of the monitor should match that of the video camera. Three chip cameras require monitors with 700 lines resolution to realize the improved resolution of extra chip sensors. Two separate monitors on each side of the table are commonly used for most laparoscopic procedures. The use of special video carts for housing the monitor and other video equipments allows greater flexibility and maneuverability.



Figure 7



Documentation: VHS recorder, video printer and sometimes DVD recorder are standard documentation equipment housed in the video cart.

2. Equipment for creating / maintaining domain

Gas insufflation:

CO₂ Insufflator: (figure 8) The creation of working space in the abdominal cavity is generally done using CO₂ delivered via an automatic, high flow, pressure regulated insufflator. CO₂ is currently the agent of choice due to low risk of gas embolism, low toxicity to peritoneal tissues, rapid reabsorption, low cost and inhibits combustion. The insufflator delivers gas at a flow rate of up to 20 liters / min. It also regulates the intra-abdominal pressure and stops delivery of CO₂ when the pressure exceeds the predetermined level. This level is usually set at 12 to 15 mm Hg due to risk of hypercarbia, acidosis and adverse hemodynamic and pulmonary effects at higher pressure. The insufflator is equipped with an alarm, which sounds when the pressure limit is exceeded. Nitrous oxide has unpredictable absorption characteristics and may support combustion limiting clinical utility. Helium is inert but risk of gas embolism is significant.

Never ignore any alarm that sounds during laparoscopic surgery!



Figure 8

Gasless laparoscopy (figure 9): This has some theoretical advantages in some high-risk patients with compromised cardio-respiratory function, decreased diaphragmatic splinting. It facilitates continuous suction and use of some conventional open instruments. However, the exposure may be sub-



Figure 9



optimal due to tent like retraction of the abdominal wall. There may be localized trauma to the abdominal wall, parietal peritoneum resulting in more pain.

3. Instruments for Access

Veress needle: The Veress needle is designed to create pneumoperitoneum prior to insertion of trocar in a closed fashion (figure 10). It consists of an outer sharp cutting needle and inner blunt spring-loaded obturator. During insertion of the veress needle into the peritoneal cavity, resistance at the fascia causes the blunt tip to retract backwards enabling penetration by the sharp outer needle. Once the cutting edge penetrates freely into the peritoneal cavity, the blunt stylet springs forward beyond the cutting edge preventing injury to intraperitoneal structures. The inner stylet is hollow with a side hole near its tip to allow insufflation with air.



Figure 10



Figure 11

Open access trocars: Hasson's

cannula: The Hasson's cannula (figure 11) is used for gaining initial access to the abdominal cavity with an open cutdown technique. It has a conical blunt tip that is fitted into the cut down site and buttressed in

place with fascial sutures attached to the wings of the cannula.



Figure 12

Optical trocar: Optical trocar (figure 12) allows visualization of the tissues as the blade cuts through the layers of the abdominal wall.

4. Operative Instruments

Trocars: The basic laparoscopic port consists of an outer hollow sheath or cannula that has a valve to prevent the CO₂ gas from escaping, a side port for instillation of gas. Inner removable trocar fits through the outer sheath and is used while inserting the port



through the abdominal wall. Trocars are available in various diameters and sizes according to requirements, 10mm and 5 mm being commonly used. Disposable trocars (figure 13) are equipped with a retractable safety shield that sheaths the trocar tip upon entry into peritoneal cavity. Disposable rubber converters or reusable metallic reducing sheath are available for reusable trocars (figure 14) to prevent air leakage from the cannula when smaller diameter instruments are used.



Figure 13



Figure 14

Retraction: Exposure may be facilitated by pneumoperitoneum which provides uniform retraction of the peritoneal cavity, gravity i.e. tilting the table, instruments for retraction. Instrumental retraction: Retraction may be achieved using large grasping instruments.



Figure 15

Instruments lying outside the visual field may cause inadvertent damage to unvisualized structures. Specifically designed fan-shaped retractors are used for tissue retraction especially for solid organs as liver (figure 15).

Mechanical Dissecting instruments:

Most laparoscopic instruments are 30 to 40 cm in length with a shaft diameter of 3 to 10mm. The shafts of the instruments may be insulated with non-conductive material with only the working tip is metallic to allow diathermy through coagulation adapters. Most laparoscopic forceps have atraumatic tips and have mechanism to rotate 360 degrees for optimal adjustment of the instruments when used in different planes.

Forceps: Grasping forceps are used for holding and haemostasis and dissection (Endo-Grasp) (figure 16) Dissecting forceps are straight or curved (Endo dissect) with blunt tips. There are instruments that articulate up to 80 degrees (Roticulator) to provide



Figure 16



access to areas, which are not easily reached to provide comfortable hand and arm position for the surgeon. Grasping instruments come with either atraumatic or toothed jaws. The handles have a ratchet mechanism for locking onto the tissues to prevent fatigue when the surgeon holds the tissues for a long time.



Figure 17

Bowel and lung clamps: Tubular structures, bowel and lung can be held with instruments designed specifically for the same. (Endo-Babcocks, Endo-Lung, Bowel Clamp) (figure 17)



Figure 18

Scissors: There are a variety of scissors (figure 18) for dissecting, mobilizing and cutting tissues, which include straight and curved types (Endo Shears). Hook scissors are used to cut sutures, tough fibrous tissues. Most dissecting scissors have adapters for

diathermy.

Hook scissors should always be kept in view while entering and exiting.

Repeated use of diathermy at the sharp edge may tend to blunt the scissors.

5. Energy Sources

Electrosurgery: Background

Current flow occurs when electrons flow from one atom to the orbit of an adjacent atom. Voltage is the “force” or “push” that provides electrons with the ability to travel from atom to atom. If electrons encounter resistance, heat will be produced. The resistance to electron flow is called impedance. A completed circuit must be present in order for electrons to flow. A completed circuit is an intact pathway through which electrons can travel.

Current = Flow of electrons during a period of time, measured in amperes



Circuit = Pathway for the uninterrupted flow of electrons

Voltage = Force pushing current through the resistance, measured in volts

Resistance = Obstacle to the flow of current, measured in ohms (impedance = resistance)

Electrocautery refers to direct current (electrons flowing in one direction) whereas electrosurgery uses alternating current. During electrocautery, current does not enter the patient's body. Only the heated wire comes in contact with tissue. In electrosurgery, the patient is included in the circuit and current enters the patient's body. The electrosurgical generator is the source of the electron flow and voltage. The circuit is composed of the generator, active electrode, patient, and patient return electrode. Pathways to ground are numerous but may include the OR table, stirrups, and equipment. The patient's tissue provides the impedance, producing heat as the electrons overcome the impedance. Standard electrical current alternates at a frequency of 60 cycles per second (Hz). Electrosurgical systems could function at this frequency, but because current would be transmitted through body tissue at 60 cycles, excessive neuromuscular stimulation and perhaps electrocution would result. Because nerve and muscle stimulation cease at 100,000 cycles/second (100 kHz), electrosurgery can be performed safely at "radio-frequencies well above 100 kHz. An electrosurgical generator takes 60 cycles current and increases the frequency to over 300,000 cycles per second. At this frequency electrosurgical energy can pass through the patient with minimal neuromuscular stimulation and no risk of electrocution.

Bipolar: In bipolar electrosurgery, both the active electrode and return electrode functions are performed at the site of surgery. The two tines of the forceps perform the active and return electrode functions. Only the tissue grasped is included in the electrical circuit.



Bipolar Circuit: (figure 19)

This picture represents a typical bipolar circuit.

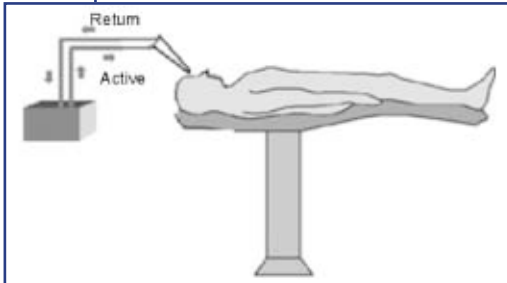


Figure 19

Monopolar: The active electrode is in the wound. The patient return electrode is attached somewhere else on the patient. The current must flow through the patient to the patient return electrode to complete the circuit.

Monopolar Circuit (figure 20)

There are four components to the monopolar circuit:

- Generator
- Active Electrode
- Patient
- Patient Return Electrode

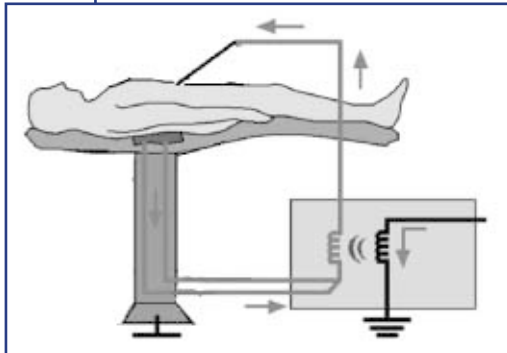


Figure 20

Electrosurgical generators are able to produce a variety of electrical waveforms. As waveforms change, so will the corresponding tissue effects. Using a constant waveform, like "cut," the surgeon is able to vaporize or cut tissue. Using an intermittent waveform, like

"coagulation," causes the generator to modify the waveform so that the duty cycle (on time) is reduced. This interrupted waveform will produce less heat. Instead of tissue vaporization, a coagulum is produced. A "blended current" is not a mixture of both cutting and coagulation current but rather a modification of the duty cycle. High heat produced rapidly causes vaporization. Low heat produced more slowly creates a coagulum.

Safety Considerations during Electrosurgical laparoscopic surgery

Direct Coupling: Direct coupling occurs when the user accidentally activates the generator while the active electrode is near another metal instrument. The secondary instrument will become energized. This energy will seek a pathway to complete the circuit to the patient return electrode. There is potential for significant patient injury.



Do not activate the generator while the active electrode is touching or in close proximity to another metal object.

Insulation Failure: (figure 21) Many surgeons routinely use the coagulation waveform. This waveform is comparatively high in voltage. This voltage or “push” can spark through compromised insulation. Also, high voltage can “blow holes” in weak insulation. Breaks in insulation can create an alternate route for the current to flow. If this current is concentrated, it can cause significant injury.

You can get the desired coagulation effect without high voltage, simply by using the “cutting” current while holding the electrode in direct contact with tissue. This technique will reduce the likelihood of insulation failure. By lowering current concentration you will reduce the rate at which heat is produced and rather than vaporize tissue you will coagulate - even though you are activating the “cutting” current.

Capacitive Coupling: A capacitor is not a part labeled “capacitor” in an electrical device. It occurs whenever a nonconductor separates two conductors. During laparoscopic procedure, an “inadvertent capacitor” maybe created by the surgical instruments. The conductive active electrode is surrounded by nonconductive insulation. This, in turn, is surrounded by a conductive metal cannula.

A capacitor creates an electrostatic field between the two conductors and, as a result, a current in one conductor can, through the electrostatic field, induce a current in the second conductor.

In a laparoscopic procedure, a capacitor may be created by the surgical instrument’s composition and placement.

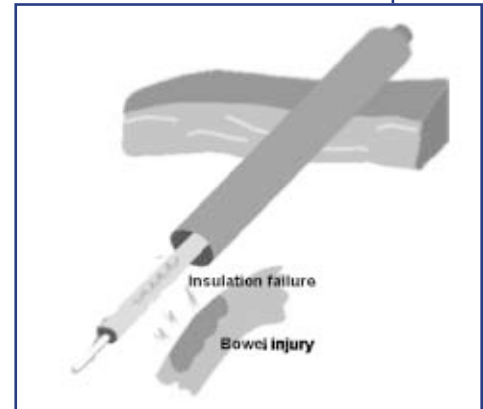


Figure 21



Avoiding Electrosurgical Complications

Most potential problems can be avoided by following:

- Inspect insulation carefully
- Use lowest possible power setting
- Use a low voltage waveform (cut)
- Use brief intermittent activation vs. prolonged activation
- Do not activate in close proximity or direct contact with another instrument
- Use bipolar electrosurgery when appropriate
- Select an all-metal cannula system as the safest choice. Do not use hybrid cannula systems that mix metal with plastic
- Utilize available technology, such as a tissue response generator to reduce capacitive coupling or an active electrode monitoring system, to eliminate concerns about insulation failure and capacitive coupling.

NOTE: Any cannula system may be used if an active electrode monitor is utilized

- The electrosurgical unit should not be used in the presence of flammable agents (i.e., alcohol and/or tincture-based agents)
- Avoid oxygen-enriched environments.
- ALWAYS use an insulated safety holster to store active electrodes when not in use.

Monopolar current may be used through most of the dissecting and cutting laparoscopic instruments. The dissecting 'Hook' is a useful instrument for effectively using blunt dissection and for diathermy.

Argon-Enhanced Electrosurgery: Argon-enhanced electrosurgery incorporates a stream of argon gas to improve the surgical effectiveness of the electrosurgical current. Argon gas is inert and noncombustible making it a safe medium through which to pass electrosurgical current. Electrosurgical current easily ionizes argon gas, making it more conductive than air. This highly conductive stream of ionized gas provides the electrical current an efficient pathway.



- Inert
- Noncombustible
- Easily ionized by RF energy
- Creates bridge between electrode and tissue
- Heavier than air
- Displaces nitrogen and oxygen

Ultrasonic Energy: The *Harmonic scalpel* (Ethicon Endo-Surgery) uses ultrasonic technology, the unique energy form that allows both cutting and coagulation at the precise point of impact, resulting in minimal lateral thermal tissue damage. Harmonic Scalpel (figure 22) cuts and coagulates by using lower temperatures than those used by electrosurgery or lasers. Harmonic Scalpel technology controls bleeding by coaptive coagulation at low temperatures ranging from 50°C to 100°C: vessels are coapted (tamponaded) and sealed by a protein coagulum. Coagulation occurs by means of protein denaturation when the blade, vibrating at 55,500 Hz, couples with protein, denaturing it to form a coagulum that seals small coapted vessels. When the effect is prolonged, secondary heat is produced that seals larger vessels. It offers greater precision in tight spaces near vital structures. Fewer instrument changes are needed, less tissue charring and desiccation occur, and visibility in the surgical field is improved.



Figure 22

Cutting speed and coagulation are inversely related. With ultrasound technology, the balance between cutting and coagulation is in the hands of the surgeon. Cutting speed and extent of coagulation are easily controlled and can be balanced by varying four factors: power, blade sharpness, tissue tension, and grip force/pressure.

Power Setting: The Harmonic Scalpel LCS has five power levels. Increasing the power level increases cutting speed and decreases coagulation. In contrast, less power decreases cutting speed and increases coagulation. More power results in increased



distance traveled by the blade: at level 1, blade excursion is approximately 50 microns; at level 3, approximately 70 microns; at level 5, it is approximately 100 microns. The ultrasonic vibration of 55,500 Hz remains the same at all power levels. **Tissue Tension** More coagulation can be achieved with slower cutting when tissue tension is reduced. Faster cutting with less coagulation is achieved by increasing the tissue tension. **Grip Force/Pressure:** Grip force, or pressure, is another factor controlling the balance between cutting and coagulation. Application of a gentle force, or light pressure, achieves more coagulation with slower cutting. A firmer grip force achieves less coagulation with faster cutting.

6. Instruments for Tissue approximation/ Hemostasis

1. **Laparoscopic ligating suture delivery system:** A Pre-tied sliding knot (figure 23) with a loop is available with nylon carrier rod to ligated stump like structures or tubular structures after cutting. Eg Surgitie. The push rod and suture loop are inserted laparoscopically via a hollow reducing sleeve; the suture is then looped around the structure to be ligated and the knot is slid down to close the loop. Useful in appendicectomy.



Figure 23

2. **Needle drivers:** A number of laparoscopic needle holders (figure 24a) have been designed for laparoscopic suturing with either spring loaded or ratcheted –handle mechanisms. Endostich (figure 24b) is a 10mm disposable suturing device. The needle features a sharp tapering point at each end with suture attachment at the center of the needle. The double-ended

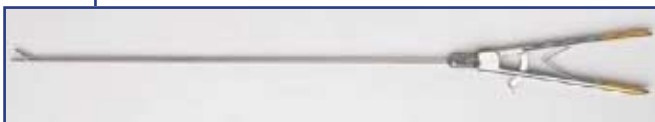


Figure 24a



Figure 24b

needle is passed between the two jaws of the suturing device. Its advantages include easy introduction, atraumatic needle manipulation, good security and easy accurate needle placement. Disadvantage is that it is difficult to manipulate the thickness of tissue through with needle passes.



Figure 25

3. **Clip Applicators:** (Figure 25) Clip applicators are primary modality for ligating blood vessels and other tubular structures. Disposable clip applicators contain up to 20 clips, whereas reusable clip applicators carry one clip at a time. Clips are made of titanium though now absorbable clips are also available.

Mechanical Stapling Instruments: (figure 26)

Laparoscopic staplers are modifications of stapling devices of open surgery. Staplers are used for transecting and anastomosing bowel, transecting mesentery etc. Multifire Endo GIA: The instrument's knife cuts between two triple staggered rows of staples. TA instrument differs from GIA in that it only staples and doesn't cut. A range of staple lengths (2.5-3.8mm) is available depending on the thickness of the tissue to be divided.



Figure 26

7. Miscellaneous

Aspiration / Irrigation probes: (figure 27) These are essential for most laparoscopic procedures in order to maintain a clear operative field. Irrigation and aspiration channels may be incorporated into surgical instruments but working channels are small and subject to repeated clogging.



Figure 27

Hand Assisted Laparoscopic surgery: (figure 28) The Hand Access Device is intended to provide extracorporeal extension of pneumoperitoneum and abdominal access for the surgeon during laparoscopic surgery. It is indicated for use in laparoscopic



Figure 28

procedures, where entry of the surgeon's hand may facilitate the procedure, and for extraction of large specimens. It has application in colorectal, urological and general surgical procedures. This indication for use includes the specific procedures, which fall under these broad categories.

Organ Extraction devices: Eg; Endo-Catch (figure 29).

These are pre loaded specimen retrieval pouches made of strong material, which is impervious to cancer cells. The mouth of the pouch is brought out of the incision site and opened following which the specimen is extracted.

The pouch itself must not be pulled out against resistance at it may tear with undue force



Figure 29

Tissue Morcellators: These are used to reduce the size of the resected specimen prior to retrieval. *It may render pathological examination more difficult*

Space creators: Balloon dissector (Figure 30) is a space disectors which functions when saline or air instilled into the pre-shaped balloon inserted into the intended region. These are used for laparoscopic extraperitoneal surgery eg hernia repair, endoscopic neck surgery, subfascial endoscopic ligation of perforators veins, retroperitoneal surgery, etc.



Figure 30



CARE AND HANDLING OF LAPAROSCOPIC INSTRUMENTATION

Shirin Khor Pui Kwan

Laparoscopic instrumentation ranging from operating telescopes and fibre optic light cables to its surgical instruments) represent a substantial investment for the operating theatre department. The delicate nature of these devices and the high cost involved to repair them when damaged, warrants surgeons, nurses and reprocessing personnel to handle them carefully and appropriately at all times. Proper care and handling of laparoscopic instrumentation can help to prolong their lifespan and maintain them at an optimal performance level. With the goal of delivering the finest in patient care, all surgical team members and reprocessing personnel must be familiar with the use of and recommendations for care and handling of all laparoscopic instrumentation.

CARE AND HANDLING OF TELESCOPES

The telescope is the most expensive and fragile component of laparoscopic instrumentation. It is also an integral part of the instrumentation, providing image and light through two distinct systems. As such, telescopes must be handled with care from the start to the end of surgery, and also during the cleaning and sterilization process.

All surfaces of a telescope should be inspected on a regular basis for any scratches, dents or other flaws. Telescope should also be inspected before each use to assess functional integrity. The eyepiece should be examined to evaluate the clarity of image from the reflected light. In addition, it is also important to check the optical fibers surrounding the lens train at the tip of the telescope by holding the light post toward a bright light. If image is discolored or hazy or there is presence of black dots or shadowed areas, it may be due to improper cleaning, a



disinfectant residue, a cracked or broken lens, the presence of internal moisture, or external damage.

When using a metal cannula, telescope should be inserted gently into the lumen, so as not to break the lens. At any point of time during use or cleaning and disinfection process, telescope should not be bent during handling, and avoid placing any heavy instruments on top of the telescope. The telescope also should never be placed near the edge of a sterile trolley or surgical field to prevent it from accidental dropping onto the floor. When transferring telescope from one point to another, it is best done by gripping the ocular lens in the palm of the hand and never by the shaft. Immediately after use, wash the surfaces of the telescope with a soft cloth or sponge using a neutral pH enzymatic solution and thorough rinse with distilled water to remove any residual cleaning solution.

CARE AND HANDLING OF LIGHT CABLES

Another important component of laparoscopic instrumentation is the use of a light source cable to transmit light through the telescope to view the operative field. Light cables are made of hundreds of glass fibers to transmit the light, and these fibers can be broken if the cable is dropped, kinked or bent at extreme angles. Following are some general guidelines regarding the care and maintenance of light cables :

- Avoid squeezing, stretching, or sharply bending the cable
- Grasp the connector piece when inserting or removing the light cord from the light source. Never pull the cable directly when disconnecting it from the light source
- Avoid puncturing the cable with towel clips, when securing the cables to the surgical drape
- Do not turn the light source on before connecting the light cable to the telescope to prevent igniting a fire on the surgical drape
- Inspect the cable for broken fibers before each use
- Inspect both ends of the cable to ensure they have a clean, reflective, polished surface
- Wipe the fibre optic light cable gently to remove all blood and organic materials immediately after use using a mild detergent



CLEANING, DISINFECTING AND STERILIZING OF LAPAROSCOPIC INSTRUMENTS

Reprocessing laparoscopic instruments is one of the toughest challenges to OR personnel today. These instruments are extremely difficult to clean because of their long shaft and complex jaw assemblies, which may trap infectious bioburden and debris. The positive pressure of the CO₂ in the insufflated abdomen may also cause blood and other body fluids to flow up into these channels, and making them difficult or impossible to remove. Many of these instruments cannot be disassembled to facilitate manual cleaning, and ultrasonic cleaning system may be contraindicated due to the small joints and jaws. Nevertheless, for effective sterilization to take place, it is absolutely vital for surgical instruments to be clean and free from all bioburden. And meticulous cleaning should begin at the point of use and immediately after a surgical procedure.

To assist in subsequent cleaning process, laparoscopic instruments should be periodically wiped down with a wet sponge and flushed with solutions during surgery to prevent bioburden solidification. The instruments should also be immersed in an enzymatic solution immediately following a procedure to initiate the decontamination procedure. Items in these instruments that can be disassembled should be disassembled to its smallest parts, and those with flush ports should be flushed, prior to soaking and cleaning. For the cleaning process, a detergent with a neutral pH of 7.0 is recommended, and avoids using abrasives, such as steel wool, that could disrupt the surface of the instruments. Instead use appropriate cleaning tools, such as soft bristle brushes, to adequately clean ports, lumens, serrations, fulcrums, box locks and crevices. Both external and internal surfaces of the instruments must be cleaned thoroughly, if not, they cannot be sterilized. If available, automatic cleaning devices, with port and lumen flusher systems can be used to assist in completely cleaning the instruments. Contradict to telescopes and light cables, in which should not be routinely cleaned in an ultrasonic device (as the vibration may damage the tiny fibreoptic bundles), laparoscopic instruments can be cleaned using an ultrasonic cleaner, where appropriate.



Following the cleaning process, the devices should be sterilized or high-level disinfected using chemical agents. Glutaldehyde is one of the most appropriate chemical high-level disinfectants for soaking laparoscopes and accessories because they do not damage rubber, plastics or lens cements. For sterilization, steam, liquid immersion or plasma are some of the sterilization modalities that can be used. Nevertheless, since the manufacturers are responsible for developing instructions for a process, which will render a properly cleaned instrument sterile while preserving its function, it is best that the instruments be sterilized according to manufacturers' written instructions.

CONCLUSION

Proper care and handling of laparoscopic instrumentation can help prevent malfunctions and rapid deterioration, which in turn eliminates costly repairs and replacements. It is important that each and every member of the surgical team together with the reprocessing personnel work collaboratively to achieve this important goal, so as to ensure the delivery of the safest and highest quality of patient care.





ANAESTHESIA IN LAPAROSCOPIC SURGERY

Joyce C. Choy

PHYSIOLOGICAL MODIFICATION IN PATIENTS UNDERGOING LAPAROSCOPIC SURGERY

The creation of a carbon dioxide-filled pneumoperitoneum coupled with the fairly extreme positioning of the patient during laparoscopic surgery impacts largely on the respiratory and cardiovascular systems.

The raised intra-abdominal pressure displaces the diaphragm cephalad resulting in a reduction of lung volumes whilst raising the airway pressures and increasing the patient's risk for regurgitation of gastric contents with concomitant pulmonary aspiration.

The impaired diaphragmatic movement gives rise to an uneven distribution of ventilation to the non-dependent part of the lung leading to hypercarbia and hypoxemia from a ventilation-perfusion mismatch. This ventilatory impairment is worsened if there is associated airway and alveolar collapse.

The resultant systemic hypercarbia is dependent on the amount of carbon dioxide absorbed, which in turn is affected by the duration of surgery and levels of intra-abdominal pressures achieved. Carbon dioxide crosses lipid barriers easily to cause intracellular acidosis, which has adverse effects on enzymatic function and metabolic reactions.

The physiological effects of hypercarbia are seen in the central nervous system and the cardiovascular system. Hypercarbia affects the nervous system by increasing cerebral blood flow leading to raised intracranial pressure. Its effect on the cardiovascular system includes sympathetic stimulation (tachycardia) with generalized peripheral vasodilatation. The patient appears warm, flushed, sweaty and tachycardic with a



bounding pulse. It also increases the risk of arrhythmias and decreases myocardial contractility. As the patient is usually paralyzed, the normal ventilatory compensatory component is obtunded. A slow infusion of carbon dioxide (less than 1 L/min) can be absorbed across the pulmonary capillary-alveolar membranes without causing any damage. At higher infusion rates, the gas bubbles lodging in the peripheral pulmonary arterioles provoke neutrophil clumping, coagulation cascade and platelet activation. This may lead to pulmonary vasoconstriction, bronchospasm, pulmonary oedema and sometimes pulmonary haemorrhage. Gas bubbles which attach to fibrin deposits and platelet aggregates mechanically obstruct the pulmonary vasculature and increases the pulmonary vascular resistance. This increased right heart afterload leads to acute right heart failure with arrhythmias, ischaemia, hypotension and elevated central venous pressure.

Systemic vascular resistance rises with increased intra-abdominal pressure (IAP). Venous return initially increases with IAP < 10 mmHg, this paradox is due to reduction in the blood volume sequestered in the splanchnic vessels which increases cardiac output and arterial pressure. However, when IAP > 20 mmHg, the inferior vena cava is compressed; venous return from the lower half of the body is impeded resulting in a fall in cardiac output. Decreases in cardiac output is seen with IAP 20-30 mmHg in humans, but in laparoscopic cholecystectomy, reduced cardiac output is seen at 15 mmHg due in part to the reverse Trendelenburg position.

The renal circulation becomes compromised with increased intra-abdominal pressure. Renal blood flow and glomerular filtration rate decreases because of the increase in renal vascular resistance, reduction in glomerular filtration gradient and decreased cardiac output. The increase in systemic vascular resistance impairs left ventricular function and cardiac output. Arterial pressure remains relatively unchanged, which conceals the fall in cardiac output. High intra-thoracic pressure during intermittent positive pressure ventilation further impairs the venous return and cardiac output. Lactic acidosis is a consequence of impaired hepatic clearance of lactate from the reduction of cardiac output.



Finally, arrhythmias such as AV dissociation, nodal rhythm, sinus bradycardia and asystole are due to stimulation of the vagus nerve from peritoneal stretching.

PREOPERATIVE ASSESSMENT

The preoperative assessment seeks to assess the patient's airway and ensure that all medical conditions are optimized before surgery. Particular attention is paid to the cardiovascular system (all murmurs should be investigated for the risk of paradoxical embolism as 25-40% of the population has a potential patent foramen ovale), respiratory system and those conditions, which predispose a patient to the risks for aspiration (eg. Obesity, incompetent lower oesophageal sphincter in hiatus hernia).

PREMEDICATION

Premedication is generally unnecessary. However, for the anxious patient, a benzodiazepine can be given. The dose given will commensurate with the patient's age and associated medical conditions.

CHOICE OF ANAESTHESIA

General anaesthesia with intubation using a muscle relaxant is usually chosen. The institution of intermittent positive pressure ventilation allows the anaesthesiologist to manipulate the tidal volumes and respiratory rates necessary to counteract the respiratory changes resulting from the pneumoperitoneum and positioning of the patient. On the rare occasion, local and/or regional anaesthesia with intravenous sedation can be used for certain short procedures.

POSITIONING AND PREPARATIONS

The patient should be securely strapped to the operating table with his/her bony points padded. He/she may be put in either the reverse Trendelenburg or Trendelenburg or lithotomy position depending on the type of surgery. Attention should be paid to protecting the face (especially the eyes) from inadvertently being hit by the laparoscopic instruments or the surgeon's arm. If the



patient's arm is extended, care should be taken to avoid hyperabduction thus reducing the risk of brachial plexus injury. Padding the elbows protects the ulnar nerve whilst the common peroneal nerve needs to be attended to in the lithotomy position.

INTRAOPERATIVE MONITORING

Routine monitoring during laparoscopic surgery include pulse oximetry (approximates the partial pressure of oxygen in the blood), end-tidal carbon dioxide monitoring (approximates the partial pressure of carbon dioxide in the blood), non-invasive blood pressure monitoring (gives an indication of the cardiac output), and electrocardiography (to detect arrhythmias). Airway pressure monitoring is also considered desirable as it warns against excessively high airway pressures and may detect the presence of a pneumothorax.

POSTOPERATIVE MANAGEMENT

Major postoperative problems after laparoscopic surgery include pain and nausea. The former can be reduced with the appropriate use of various classes of analgesics (eg. NSAIDs, opioids, etc) in conjunction with local anaesthetics for local or regional blockade wherever possible. The classical shoulder tip pain can be reduced by having the surgeon attempt to remove as much of the pneumoperitoneum as possible at the end of surgery.

Postoperative nausea and vomiting (PONV) can be reduced by avoiding over-inflation of the stomach during mask ventilation, identifying those at risk of PONV, reducing the use of opioid analgesics where possible and the liberal use of anti-emetics.



METHODS OF ACCESS, PNEUMOPERITONEUM and COMPLICATIONS.

Davide Lomanto

The purpose of this chapter is to describe the fundamental step to safely enter into the abdominal cavity and to create the pneumoperitoneum. This is the first maneuver to learn and even though seems to be simple is not risk less. The complications rate range from 0.05 to 0.2% but even low represent almost 20-30% of the complications of the laparoscopic surgery.

There are different methods of laparoscopic access with numerous modifications. The most common utilized are: Veress needle access, open access using Hasson's trocar, direct trocar insertion and optical trocar access. The preference is a surgeon's choice and must be also related to different patients and different situations. Gaining access to the peritoneal cavity is essential to the success of laparoscopic surgery. Occasionally, it can be difficult especially for obese patients and it can cause potentially dangerous complications in some patients.

VERESS NEEDLE TECHNIQUE

This special needle has an outer cannula with a beveled needle. The length of the needle range from 7 to 15 cm, with an external diameter of 2 mm. The cannula is an inner stylet that springs forward in response to sudden decrease in pressure upon crossing the abdominal wall and entering the peritoneal cavity. The dull stylet serves to protect the underlying viscera.



Technique: Usually a small incision is made above or below the umbilicus. The anterior abdominal wall is lifted up using a clamp by the surgeon and assistant on either side of umbilicus to create a negative abdominal pressure. The Veress needle is then inserted into the peritoneal cavity, usually a 'give' can be felt. The patient should be in Trendelenburg's position and it should aim towards the pelvis. Once inserted and hold in a steady position, three methods can be used to test the proper position of the needle using a syringe: injection of saline, suction of air and the drop test. Subsequently, a low flow insufflation of CO₂ is started with a careful reading of the electronic insufflator. The intra-abdominal pressure (around -1 and 4 mmHg) is very important and also the percussion of the abdomen over the liver that, obliteration of the liver dull sounds, show a diffusion of the gas into the abdominal cavity.

Once the intra-abdominal pressure reaches 13-15 mmHg, the needle is removed and the first sharp trocar can be inserted. After the port is inserted, a rapid introduction of the telescope is very important to verify the correct entry and to explore the abdominal cavity for injuries. The remaining trocars are placed differently under direct vision according to the procedure.



OPEN (HASSON) TECHNIQUE

In order to avoid inadvertent injuries to the underlying bowel associated with blind technique, Hasson proposed a *blunt minilaparotomy* access. A 2 cm incision either vertical or curvilinear is made to the skin above or below the umbilicus or differently accordingly to the procedure to be done.

Occasionally, supraumbilical incision can be used if adhesion in the pelvis is suspected. The linea alba and the peritoneum is incised under direct vision. Once the peritoneal cavity is entered, using a finger, a gently exploration of the periumbilical area is suggested to verify the presence of abdominal adhesion. Then the Hasson's trocar can be inserted. This trocar is blunt and can



be disposable or reusable. Usually the trocar is held in place by two sutures anchored on either side of the abdominal fascia. The fascia must be previously secured by Kocher clamps. The laparoscopic is inserted to confirm to be into the abdominal cavity. The CO₂ insufflation's can be started at low pressure (2-4 lt/ min). This is to avoid a rapid increase of the intra-abdominal pressure with a consequent rapid expansion of the diaphragm (vagal stimulation, arrhythmias).

The advantage of this technique include safety. It is recommended by most of general surgeons especially in patients with previous abdominal operations.

DIRECT TROCAR INSERTION

We believe that this technique must be carried out only by experienced and skilled laparoscopic surgeons. It is a form of blind direct insertion.

One reason in favor of this technique is in avoiding the use of the Veress needle and a double blind puncture of the abdomen. This technique involves an adequate skin incision (to avoid skin resistance during the sleeve insertion), the periumbilical skin must be lifted up using towel clamps on either side and a disposable trocar is used (trocar must be sharp). The trocar must be held like a pen avoiding in this way to penetrate too deep. Once the trocar is inserted, an explorative laparoscopy must be carried out to verify intra-abdominal or retroperitoneal injuries.

OPTICAL TROCAR INSERTION

There are a few available hollow trocars in the market either disposable or reusable (see chapter on "Instruments and Devices"). They are very useful in obese patients or in patients who underwent previous major abdominal surgery. A 0 degree telescope is inserted into the sheath and fixed and using a rotating movement and the cafting device, it is possible to enter into the peritoneal cavity under direct vision, layer by layer.





PNEUMOPERITONEUM

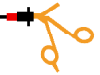
The entry into the peritoneal cavity needs to be *confirmed* before any insufflation. As previously described, this can be done by syringe and test insufflation of 1litre/min. The initial pressure on the monitor should be less than 6mmHg. The insufflation test should produce little rise in the pressure level. Once the position is confirmed, CO₂ at 4-6 l/min can be insufflated into the peritoneal cavity. The gas pressure on the insufflator should be around 12-15 mmHg.

COMPLICATIONS AND MANAGEMENT

The complications rate range from 0.05 to 0.2% but even though the rate is low, it still represents almost 20-30% of the complications of the laparoscopic surgery. **The most common are: extraperitoneal gas insufflation, vascular injury, bowel injury.** A **preperitoneal gas insufflation** is the commonest complication and can be prevented by inserting the Veress needle perpendicular at the spine and also avoiding displacement of the Needle during the gas insufflation. If during the creation of the pneumoperitoneum, the CO₂ pressures don't arise (stable below 6 mmHg) and there is not obliteration of the liver dull sound, we must verify the correct intraperitoneal position of the Veress needle or to convert to open-Hasson technique. **Bowel injuries** are unusual (0.05%-0.4%) and are due mainly to bowel adhesion. We suggest using a Hasson technique in patients with abdominal scar. Visceral injury can be also made during the first trocar blind entry. If a bowel injury is suspected a rapid identification of the location is very important. A complete bowel examination must be carried out and the injury sutured via open laparotomy, minilaparotomy or laparoscopy. The choice of "how to repair" is related to the severity of the injury, the skill and the preference of the surgeon. Other organs, such as the stomach and bladder are rarely injured. The incidence of **vascular injuries** ranges from 0.03 to 0.05%. The injuries are caused by a blind insertion of the trocar and are usually catastrophic and require a prompt surgical intervention. A conventional laparotomy with vascular repair must



be carried out. The most common vessels injured are: abdominal aorta; iliac vessel at the level of aorta bifurcation; inferior vena cava. If during the insertion of Veress needle, blood returns after the syringe test, a retroperitoneal vascular injury must be suspected. The puncture of retroperitoneal vessels is more difficult to recognize and, a careful inspection of the retroperitoneum area must be done looking at any hematoma formation. The vascular injuries are mainly due to an uncontrolled forced entry. Vessel injury can be avoided positioning the patient in Trendelenburg position's (15-20 degree) and inserting the Veress needle or the first trocar towards the sacrum.



BASIC LAPAROSCOPIC PROCEDURES

JB Y So, I Shridhar, WK Cheah, Ti TK, D Lomanto

In this chapter we describe the most common procedures starting from diagnostic laparoscopy, widely utilized before operative laparoscopic surgery emerged in the 1990's.

But first of all, we briefly define which patients are suitable for the laparoscopic procedures. The indications for each procedure are related to the procedures themselves and will be analyzed in the different paragraphs. Laparoscopic surgery, as operative technique, has some contraindications that we can divide in **Absolute** and **Relative**:

Absolute Contraindications are: Uncontrolled coagulopathies; patients unfit for General Anesthesia; generalized peritonitis; severe cardiopulmonary disease; uncontrolled intra-abdominal haemorrhage; abdominal wall infection; haemodynamic instable patients.

Relative contraindications are: pregnancy; previous multiple abdominal operations; portal hypertension; severe liver disease.

Surgeon's experience and skill are the most affecting factors.

LAPAROSCOPIC SUTURING

Laparoscopic suturing must be in the repertoire of all laparoscopic surgeons because in every procedures can be necessary to perform a suture or knot tying to stop a bleeding or to repair a damaged bowel. Sometimes it is also useful to reduce the cost of the procedures since clip applicators, staplers or endo-stitch devices are very expensive. We can use a **preformed loop ligature**



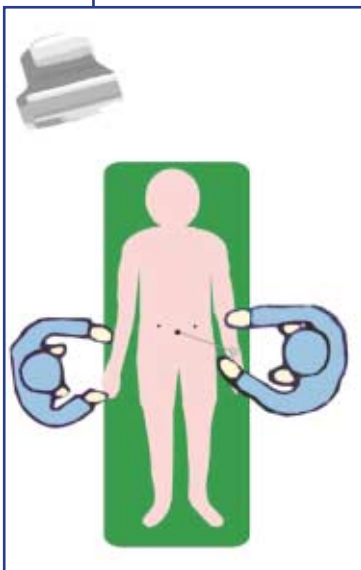
like vicryl or catgut endoloop to tie an appendix or a large cystic duct or a suture to repair a perforated peptic ulcer. Two different ways to perform a laparoscopic knot are utilized: **extracorporeal** and **intracorporeal**. Extracorporeal knot are tied outside the body and slid down using a knot pusher. A surgical knot is commonly utilized and it is easier to learn. Once the surgical knot is tied, holding one end of the suture, the other end is slid down using a knot pusher or simply using the jaw of the needle holder like the finger in open surgery. The two ends are cutted using a scissors. When a suture is performed totally into the abdominal cavity is called intracorporeal. We can utilize absorbable or not absorbable suture like in open surgery and according to the necessity. To assure an appropriate manipulation the suture must be 10 to 15 cm length; short or a long sutures are difficult to tie especially in a small space. Different needle holders are available to drive curve or straight needles into the abdominal cavity (see chapter on "Instrumentations and Devices"). The position of the trocars is very important to perform a correct and tireless suture. 60 degree is the ideal angle between the operative trocars. By the way, surgeons must be experienced with both needles. A straight needle is easy to introduce through any diameter trocar (5 to 12 mm) while a curved needle often needs to be introduced through a 10-12 mm trocar. If we are performing a procedure, using a single 10-12 mm trocar for the laparoscope with two 5 mm operative ports is necessary to redrawn the scope and we can use this trocar to insert the curved needle. It's easy to introduce the needle holding the attached suture; same maneuver to withdrawn the suture from the abdomen. During the suturing the curved needle must hold in the middle using a locking needle holder. Holding the needle with the right hand, the left hand instrument grasps the edge of the tissue to allow the needle to pass through. Same maneuver on the other edge of the tissue. Then the suture is pulled, leaving no more than 5 cm tail. Subsequently is useful to put both ends of the suture in a U-shaped fashion. The needle holder on the right hand grasps the needle and the left hand needle holder is held ready to grasp the tail of the suture. The right hand needle holder wrap the suture twice around the left needle holder, then this will grasp and pull the end of the suture. To firmly tie the knot, the surgeon must grasp, close to the knot, both the suture and pull them laterally. The



same maneuver is repeated but holding the needle with the left hand and using the right to grasp the end of the suture. Usually 2-3 knots are enough for a tied suture. A running suture can be also performed as in the trans-abdominal hernia repair (TAPP) to close the peritoneum. Usually a loop or a reabsorbable locking clip is utilized to secure the end of the suture.

DIAGNOSTIC LAPAROSCOPY

There are several situations in which the role of diagnostic laparoscopy is very useful in the effort to reduce the number of unnecessary laparotomies: acute abdominal pain, chronic abdominal pain, staging for malignancy, intestinal ischemia, bowel perforation or obstruction, pelvic inflammatory disease, gynecological causes (salpingitis, rupture of ovarian cyst or abscess, ovarian torsion, etc). We will resume in two main situations when diagnostic laparoscopy (DL) is indicated: in Acute abdomen and in Malignancy.



Patient and ports position for DL in general (see figure)

Under general anesthesia, the pneumoperitoneum was created using an umbilical access. In acute situation an open entry technique (Hasson, optical trocar) must be considered. The 30 degree telescope is then inserted through the 12 mm trocar and an initial exploration of the abdominal cavity is performed. Usually, two 5 mm trocars are necessary and inserted laterally at the umbilicus in the RIF and LIF. A diagnostic laparoscopy is started with the patient in a the supine position. Subsequently a change in table positions (Trendelenburg, anti-Trendelenburg, right or left side up, etc) will allow us to explore all the abdominal cavity and related organs. Bowel clamps and atraumatic graspers are widely utilized to inspect the abdomen.

DL in acute abdomen:

1. Intra-abdominal pain, especially RIF pain in adult female
2. Acute peritonitis where the origin is uncertain



3. Stable penetrating trauma for diagnosis of peritoneal penetration
4. suspected mesenteric ischemia

Access to the abdomen is more difficult and risky in cases of bowel dilatation and previous abdominal operations.

LAPAROSCOPY IN MALIGNANCY STAGING

Laparoscopy is a useful staging method for occult peritoneal and liver metastases. It was shown to be useful in staging for patients with carcinoma of stomach, esophagus, liver and pancreas. In some situations, a formal laparotomy can be avoided. In case of Hodgkin's lymphoma a routine diagnostic laparoscopy is very useful and the major Onco-hematology Centers use DL as a formal diagnostic tool in these patients.

A laparoscopic ultrasonography can be done utilizing a 7.5 Mhz probe and tissue sample or biopsy from liver, lymph nodes or suspected area can be easily done.

LAPAROSCOPIC SURGERY IN EMERGENCY

Laparoscopy and Acute Abdomen

Evaluation of acute abdominal pain:

Evaluation of the acute abdominal pain can be at time challenging despite the aid of modern radiology. This may result in an inappropriate delay in providing proper surgical treatment or, at the other end of the spectrum, an unnecessary exploratory laparotomy. Negative laparotomy is painful, with morbidity rate of 5% to 22% and is not cost-effective. Most surgeons face a diagnostic dilemma in evaluating lower abdominal or right iliac fossa pain in premenopausal women where in whom gynecologic causes are a part of differential diagnosis.

Sugerbaker et al proposed the use of preoperative DL in the diagnosis of acute abdominal pain in 1975. Diagnostic laparoscopy has the potential advantage of excluding or



confirming the diagnosis of acute intra-abdominal disorders expeditiously without performing a laparotomy.

Laparoscopy in Abdominal Trauma:

Majority of injured patients are not suitable for laparoscopic evaluation. Patients with hemodynamic instability or definite evidence of injury should have prompt laparotomy. Evaluation of blunt and penetrating abdominal trauma may sometimes be difficult. Many of the patients have intoxication by alcohol or other drugs, spinal cord injury, and/or head injury contributing to diagnostic difficulty. Diagnostic peritoneal lavage (DPL), ultrasonography (US), and CT—have an irreducible rate of false positivity resulting in negative examination or non-therapeutic laparotomy (E.g. positive but injury self-limiting, for example, minor, non-bleeding liver or spleen lacerations) laparotomies.

Selection criteria:

Gun shot wounds: Laparoscopy has proved most useful for evaluating the diaphragm and detecting peritoneal penetration in tangential wounds of anterior abdominal wall (Patients with mid abdominal gunshot wounds have more than 90% significant injury). Discovery of peritoneal penetration or diaphragmatic injury is indication to convert to formal laparotomy.

Stab wounds: These are not high energy transfer wounds and simple penetration of the peritoneum may not be necessarily an indication of laparotomy. With experience laparoscopic repair of some isolated injuries may be performed.

Blunt abdominal trauma: The role of laparoscopy is less well defined in the setting of blunt abdominal trauma. It may be useful adjunct to CT scan for further assessment of solid organ injuries. It provides a real time examination of liver and splenic laceration, to determine ongoing bleeding. If no active bleeding is found the need for laparotomy is obviated.

Caution: Care must be taken to prevent tension pneumothorax on insufflation of CO₂ with timely placement of tube thoracostomy.

The vital parameters are closely monitored as impaired venous return by a combination of hypovolemia and pneumoperitoneum can cause profound hypotension.

**Laparoscopy for Suspected Intraabdominal Sepsis:**

Geis et al: published series of 154 patients who underwent laparoscopy under general anesthesia in the operating room for suspected intraabdominal sepsis. Only one abscess was not identified at laparoscopy. One hundred and forty-nine patients (96%) were treated successfully using the laparoscopic approach and only five patients' required formal laparotomy. The diagnostic and therapeutic versatility of the laparoscopic approach avoids extensive preoperative diagnostic studies, averts delays in operative intervention, and appears to minimize morbidity and shorten the postoperative hospitalization. It may be argued that the ready availability of interventional radiologic means to achieve the same limits the use of laparoscopy. Nevertheless, laparoscopy is a valuable tool for those institutions in which such expertise is not readily present.

Laparoscopy in the ICU:

Intensive care unit (ICU) patients are at increased risk of developing a number of acute intra-abdominal pathologies such as acalculous or calculous cholecystitis, large bowel perforation, duodenal and gastric perforation, intestinal ischemia, pancreatitis, bowel obstruction, and intra-abdominal hemorrhage. The presence of multiple organ pathologies in these patients, ambiguities in the physical examination, and equivocal results of conventional diagnostic modalities may cause diagnostic dilemma. This may lead to an unwarranted nontherapeutic laparotomy, increasing the mortality and morbidity in these patients, or an unacceptable delay in the institution of appropriate surgical care. Diagnostic laparoscopy is a viable safe and accurate tool for managing critically ill patients in an ICU in whom there is a question of a life-threatening abdominal condition.

David Brooks has aptly summarized the advantages and disadvantages of bedside laparoscopy in ICU patients. The advantages included (1) avoiding transportation of critically ill patients; (2) rapid establishment of the correct diagnosis; and (3) avoiding unnecessary ancillary tests. However, DL is an invasive procedure that needs expertise and great patience, carries a small but definite morbidity, requires significant material and financial resources, and carries a low sensitivity for intestinal or



retroperitoneal diseases. However bedside laparoscopy represents an important armamentarium the management of critically ill ICU patients.

Laparoscopy in Small bowel Intestinal Obstruction:

The sine qua non of treatment of acute small bowel obstruction (SBO) is to intervene before gangrenous bowel develops. Clinically it can be difficult to unequivocally distinguish a complete from a partial small bowel obstruction. Diagnostic laparoscopy can be helpful in this situation.

Points to remember:

1. Initial entry must be with open technique
2. Enter away from the scar of previous surgery
3. Atraumatic instruments must be used when manipulating distended bowel.
4. In presence of gross bowel distension convert!

Duh has suggested a few criteria that can be used to select patients for laparoscopic management of an SBO

1. Mild abdominal distention, allowing adequate room for visualization
2. proximal obstruction
3. A partial obstruction
4. An anticipated simple, "single band" obstruction
5. An obstruction that readily improves with nasogastric suction

Contraindications:

1. Patients with matted adhesions
2. Carcinomatosis and those who remain distended following nasogastric intubation
3. Previous intraabdominal sepsis.

Following diagnostic laparoscopy the procedure may be converted to

1. Therapeutic laparoscopy e. g division of adhesion band
2. Laparoscopy assisted procedure E.g. Bowel resection
3. Open laparotomy.

**Suspected Acute Appendicitis:**

Recent evidence suggests laparoscopic appendectomy has lesser pain, faster recovery and lower incidence of post-operative wound infection. However there seems to be a trend toward higher intraabdominal abscesses (though not statistically significant).

A policy of early diagnostic laparoscopy in patients with suspected appendicitis decreases the risk of appendiceal perforation but also improves the diagnostic accuracy and reduces the number of negative appendectomies. It provides the surgeon with a tool not only to rule out appendicitis but also to inspect other organs simultaneously to determine the real cause of the patient's symptoms. The two important groups of patients who benefit most from diagnostic laparoscopy are (1) premenopausal women, in whom the differential diagnosis with gynecologic conditions can be difficult, and (2) obese individuals, in whom a large laparotomy incision might be required to perform a conventional appendectomy or to allow a thorough inspection of the abdominal contents. At times laparoscopic assisted approach may be used, to accurately place the incision.

The disadvantages of a laparoscopic approach include complications related to the laparoscopy such as bowel, bladder, and vascular injuries, increased cost because of the expensive equipment needs, and longer operating time, though these can be reduced with better training, credentialing and experience. The issue of increased cost remains though it may be argued that earlier return to activity may offset the higher cost.

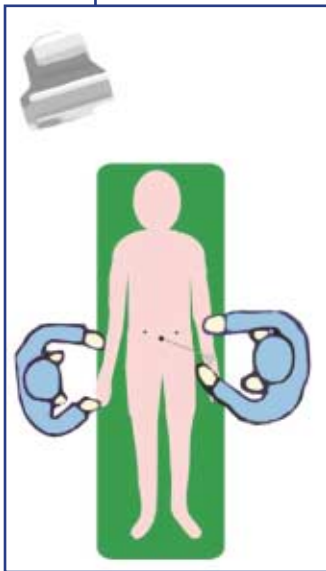
Laparoscopy in Perforated Peptic Ulcer:

Perforated peptic ulcer requires early recognition and prompt management because delay in the diagnosis translates to higher morbidity and mortality. Early diagnostic laparoscopy can determine the type of fluid present along with food debris and can locate the site of perforation in the majority of cases. However, some controversy remains regarding the efficacy of a laparoscopic repair of a perforated peptic ulcer following a significant delay in the diagnosis as delay leads to inflammatory changes, which make the repair difficult and hazardous.



Laparoscopic repair of a perforated duodenal ulcer can be achieved by simple suture closure, omental patch, use of fibrin glue, placement of an oxidized cellulose sponge, falciform ligament patch, or ligamentum teres patch.

Many studies have shown a decreased need for analgesia requirements in the postoperative period but no benefit in terms of the length of hospital stay, time to resume normal diet, visual analogue pain score in the first 24 hours, or early return to normal activity could be demonstrated. However, large, well-controlled prospective randomized trials are required to ascertain the exact role for the laparoscopic approach.



Patient and ports position's (see figure)

Techniques: After a laparoscopic examination, the peritoneal fluid is aspirated for bacteriological examination. A single stitch (3/0 vicryl) is applied with a bite of healthy tissue taken longitudinally across the perforation. A surgeon's knot is made intracorporeally. After completion of three throws, a bite is taken on a piece of healthy omentum and a surgeons knot is secured again. A thorough peritoneal lavage is then carried out.

Laparoscopy and Emergency Groin Hernia Repair

Irreducible or obstructed hernias need to be tackled by and open approach. However in a subset of patients in whom the bowel has spontaneously reduced and the viability of bowel is in question, a diagnostic laparoscopy may be done and if bowel is viable an intraperitoneal onlay mesh (IPOM) or trans-abdominal Pre-peritoneal repair (TAPP) may afford definitive treatment. Alternatively laparoscope may be passed through the hernia sac to assess the viability at an open operation.

Laparoscopy and Acute abdomen in Pregnancy:

Unfortunately, urgent surgical intervention in the gravid patient is occasionally necessary. The two most common situations encountered by the general surgeon are acute appendicitis and acute cholecystitis.

Delayed diagnosis and resultant appendiceal rupture may have dire fetal and maternal consequences. Acute cholecystitis leads to surgical intervention less frequently but despite the



effectiveness of non-operative care, pregnant patients with symptomatic gallstones have a high rate of recurrent symptoms. Nearly 70% of patients with gallstone pancreatitis will have recurrent biliary pain usually requiring hospitalization.

Potential advantages of laparoscopic appendectomy and cholecystectomy in the pregnant patient include decreased fetal depression due to lessened postoperative narcotic requirements, lower risks of wound complications and diminished postoperative maternal hypoventilation, possible rapid maternal recovery.

The risks include uterine injury during Veress needle and/or trocar placement (hence open technique is recommended), decreased uterine blood flow or premature labor from the increased intra-abdominal pressure, and increased fetal acidosis or other unknown long term effects due to CO₂ pneumoperitoneum.

Society of American Gastrointestinal Endoscopic Surgeons (SAGES) recommendations for laparoscopy in pregnancy:

1. Obstetrical consultation should be obtained preoperatively.
2. When possible, operative intervention should be deferred until the second trimester, when fetal risk is lowest.
3. Pneumoperitoneum enhances lower extremity venous stasis already present in the gravid patient and pregnancy induces a hypercoagulable state. Therefore pneumatic compression devices should be utilized whenever possible.
4. Fetal and uterine status, as well as maternal end tidal CO₂ and/or arterial blood gases, should be monitored.
5. The uterus should be protected with a lead shield if intraoperative cholangiography is a possibility. Fluoroscopy should be utilized selectively.
6. Given the enlarged gravid uterus, abdominal access should be attained using an open technique.
7. Dependent positioning should be utilized to shift the uterus off of the inferior vena cava.



8. Pneumoperitoneum pressures should be minimized (to 8 - 12 mm Hg) and not allowed to exceed 15 mmHg.

Summary:

Laparoscopy should be incorporated into the general surgeon's armamentarium for the management of patients with abdominal pain as just another tool to be used selectively when indicated. It is also important that laparoscopy in increasingly new settings be carefully evaluated and judiciously used with strict protocols to obtain objective data. Only then new guidelines will be put forth for safe and effective use of new devices.

LAPAROSCOPIC APPENDECTOMY

Appendectomy is one of the most frequently performed surgical procedures in general surgery. Today, in developed countries, about 8% of the population is appendectomized for acute appendicitis at some point during their lifetime. Laparoscopic appendectomy (LA) has been practiced for more than 20 years since Semm performed the first laparoscopic appendectomy in 1983 but the method has not achieved as great appreciation as laparoscopic cholecystectomy. There are at least 30 randomized trials and 5 meta-analyses reported in the literature. The results of meta-analyses have shown that LA causes less postoperative pain, resulting in faster recovery and shorter hospital stay. In addition, they found that LA is associated with fewer wound infections than open appendectomy. Now, LA has been adopted by several surgeons worldwide as standard procedure in patients with suspicion of acute appendicitis, even those with perforated appendicitis. Although laparoscopic appendectomy for uncomplicated appendicitis is feasible and safe, its application to perforated appendicitis is uncertain. Perforated appendicitis occurs in 20% to 30% of patients with acute appendicitis. This condition is associated with a significant risk of postoperative complications such as wound infection and intra-abdominal abscess. However, the benefits of LA in patients with perforated appendicitis remain uncertain. LA has less wound contamination during operation and direct visualization during peritoneal washing. Nevertheless, a few reports in the literature have

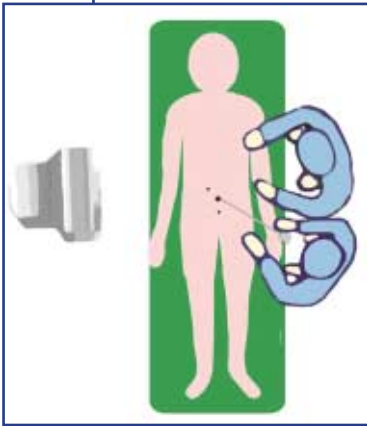


suggested that there has been an increase in infectious complications following LA for perforated appendicitis. Another theoretical argument is the risk of bacterial translocation with carbon dioxide pneumoperitoneum. We also reviewed our experience looking at the results of laparoscopic appendectomy for perforated appendicitis and compared them with those for conventional open appendectomy during the same period. A retrospective study of all patients admitted in our hospital with perforated appendicitis from 1992 to 1999 was performed. A series of 231 patients were diagnosed as having perforated appendicitis. Of these patients, 85 underwent laparoscopy (LA), among whom 40 (47%) required conversion to an open procedure. An open appendectomy (OA) was performed in 146 patients. The operating time was similar for the two groups. Return of fluid and solid diet intake was faster in LA than OA patients ($p < 0.01$). Postoperative infections including wound infections and abdominal abscesses occurred in 14% of patients in the laparoscopy group and in 26% of those with OA ($p < 0.05$).

In conclusion, it may be assumed that laparoscopic appendectomy is a safe procedure, and that postoperative morbidity is comparable with that for a conventional. There was less postoperative pain and shorter recovery time after laparoscopic surgery than after the open procedure. We must also remind what really one of the main advantages of laparoscopy is: the visualization of the abdominal cavity. First, laparoscopy assists in diagnosis; this has been shown as an advantage in the case that any other pelvic or abdominal pathology is likely and also, for example, in fertile women, who prefer laparoscopy for cosmetic reasons. Second, it could enable the surgeon to refrain from appendectomy, if the appendix has a normal appearance. The question of whether removing the appendix in these cases is justified, is not fully clear yet. Furthermore, some other pathology and conditions can be managed totally by the laparoscopic method, thus transferring benefits of laparoscopy to the patient. While for perforated appendectomy, laparoscopic approach is associated with a high conversion rate even though the surgeon's experience is correlated with the conversion rate. If successful, it offers patients faster recovery and less risk of infectious complications.



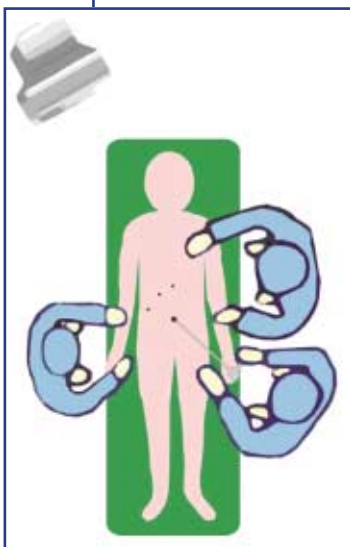
Patient and Trocar position's (see figure)



Operative Techniques:

After pneumoperitoneum is created, a diagnostic laparoscopy to exclude other pathology is performed. Patient is then put in head down and slight right lateral position. The working port in the LIF position is inserted. A bowel clamp is used to expose the appendix. Once appendicitis is confirmed, another port at suprapubic area is inserted.

Appendix is lifted up with the left hand, mesoappendix is then divided with caution using various techniques e.g. monopolar hook, bipolar cautery, clip applier or ultracision. The base of appendix would then be ligated with Endoloop ligatures (x3). Alternative method suggested in case of severe acute inflamed or perforated appendix the use of an articulated linear stapler EndoGia (30-45 mm) with vascular cartridge. Appendix is then divided with scissors and removed from the peritoneal cavity, eventually using a plastic bag. Peritoneal lavage could be carried out and hemostasis ensured before laparoscope is removed. A drainage can be inserted in case of perforated appendix or severe acute inflammation. The umbilical port needed to be closed in layers to prevent hernia formation.



LAPAROSCOPIC CHOLECYSTECTOMY

Patient and Trocars position's (see figure)

Operative Techniques:

We use a 30 degree laparoscope through an umbilical port. A diagnostic laparoscopy is performed, and 3 other working trocars are inserted under direct vision. The trocars must be inserted under vision as follows: a 5-12 mm port is inserted 1 cm below and on the left of the subxiphoid process; a 5 mm port is then inserted right subcostal (at the level of right mid-clavicular line), and perpendicular at the cystic duct; the last 5 mm trocar's



is inserted at the level of the anterior axillary line (5-8 cm below the right subcostal margin). This trocar is used to retract the gallbladder. If we are going to carry out an intraoperative cholangiography (with or without a common bile duct exploration) the position of the right subcostal trocar's is very important. Patient is positioned head-up and right side-up. An assistant using a grasper, retract the fundus of GB cranially to expose the Calot's area. The surgeon, with a grasper on the left hand, retracts the neck of GB laterally in order to open up the peritoneum and the Calot's triangle (either anteriorly and posterior). Dissection should start from the neck of GB and proceed medially and laterally, to expose the cystic duct-GB junction. It's recommended to use diathermy very carefully in this area, to avoid late ischemic injury of the structures. Once the cystic artery and cystic duct are identified, the artery is then clipped and divided. Then, the both ends of cystic duct are clipped and the duct is divided. If an intraoperative cholangiography is contemplated at this point we use clips on both cystic artery and cystic duct cranially without dividing the structures. At this point, the infundibulum of the gallbladder is retracted using a grasper through the left subcostal access. A scissors, inserted through the right subcostal port, makes a small cut on the anterior site of the cystic duct. The scissors is removed and cholangiographic clamp is inserted through the same port. A 4 Fr urethral catheter is inserted into the cholangiographic clamp and connected with a syringe and filled with saline to avoid artifact like air bubble. The 4 Fr. urethral catheter is commonly utilized to cannulate the cystic duct and to inject the contrast agent. The duct is clamped to avoid the spillage of contrast medium during the cholangiography. A dynamic cholangiogram is performed to visualize either the biliary tree anatomy or eventually filling defect like stone/s. If the fluoroscopic image and the static radiographic films are normal the clamp is removed and the cystic duct is secured by clips and divided. If not a transcystic duct exploration of the biliary duct can be performed using a flat wire basket or choledocoscope.

Alternatively a percutaneous cholangiographic catheter can be utilized inserted through the abdominal wall at the level of the mid-clavicular line.



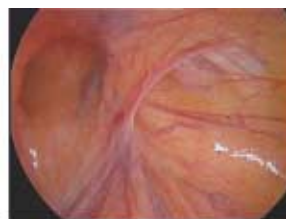
Once the cystic duct and the artery are divided, the GB is retracted away from the liver bed and slowly dissected from the liver bed using a scissors or a hook diathermy. Optimal aspiration and irrigation improves visual clarity, especially during difficult dissection. The GB is then removed through the umbilical port and the wounds closed after the hemostasis is ensured. A subhepatic suction drainage is positioned according to the surgeon's preference, through the right lateral port and fixed as usual.

ENDOSCOPIC PREPERITONEAL INGUINAL HERNIA REPAIR (TEP)

More than 100 years ago, Bassini in 1887 published his original description of inguinal hernia repair. Many modern modifications had sprung from it, such as the Shouldice repair in 1945 and the Lichtenstein "tensionless" mesh repair. Within less than a decade in the early 1990's, surgeons have not only published their early experiences on laparoscopic intraperitoneal mesh (IPOM) repair of inguinal hernia but also described two major modifications to it- the transabdominal preperitoneal repair (TAPP) and the totally extraperitoneal (TEP) repair. Such is the practice of modern science at a brisk pace.



Left direct inguinal hernia



Right direct inguinal hernia



IPOM inguinal hernia repair

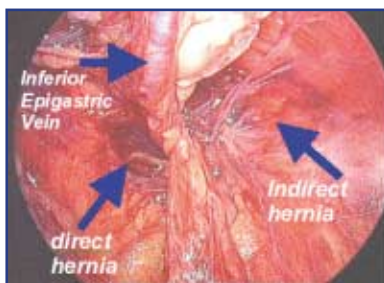
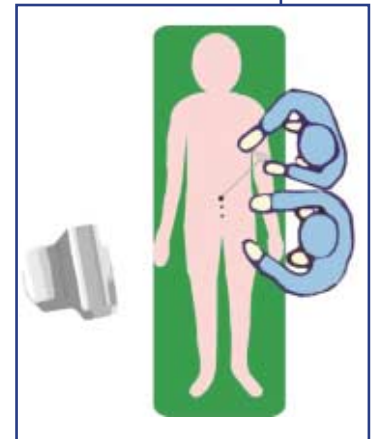
The addition of laparoscopic repairs only adds to the complexity of choosing the best hernia repair among the numerous types that have been described, but as history shows the best repair is the one that the surgeon has the greatest experience in and thus the lowest recurrence and complication rates. Laparoscopic hernia surgery has maintained its role because of the benefits to patients that are evident when compared to open repairs, as



reported in many published randomized controlled trials. Such benefits include less postoperative pain and analgesic consumption, earlier return to normal activities and work, and fewer postoperative problems such as long-term groin pain.

Patient and Trocars position's (see figure)

General anaesthetic with muscle relaxation is administered. A 1-cm infraumbilical incision is made, the anterior rectus sheath is incised, and the rectus muscle is retracted to expose the posterior rectus sheath. A balloon dissection device (Tyco, Spacemaker,) is inserted over the posterior rectus sheath, guided to the pubic symphysis and inflated, resulting in the separation of the peritoneum from the rectus muscle. This creation of the extraperitoneal space allows for laparoscopic dissection to take place. The balloon device is then removed and replaced with a 10-mm Hasson cannula and a 10-mm angled (30-degrees) laparoscope. Carbon dioxide is insufflated to a pressure not exceeding 12 mmHg. Two 5-mm cannulae are inserted in the midline for placement of laparoscopic graspers.

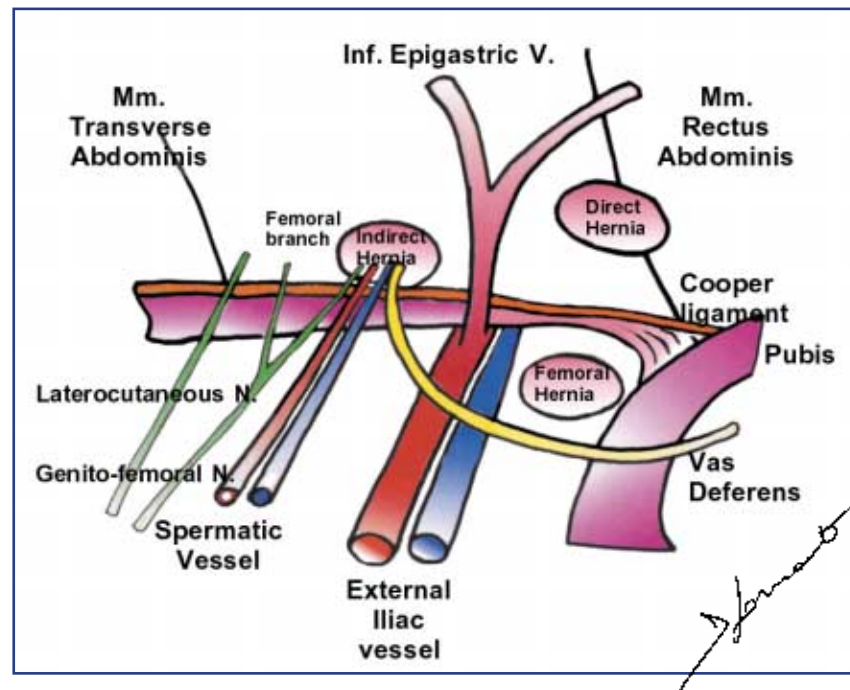


Right Side Inguinal Hernia



the Hernia defect is covered by mesh

The first step is to identify key anatomical landmarks (see figure below) such as the pubic bone, the Cooper's ligament, the spermatic cord, the inferior epigastric vessels (IEV) running superiorly, and the type of hernia in relation to it (direct hernia medial to IEV and indirect hernia lateral to IEV).



The next step is to reduce the hernia sac from the inguinal wall. The indirect hernia sac is reduced and separated from the spermatic cord. Occasionally, a long indirect sac cannot be completely reduced from the deep inguinal ring; in such cases, the sac can be divided and the peritoneal side ligated with a laparoscopic ligature (Endoloop, Ethicon, Johnson & Johnson). In the final step, a rolled polypropylene mesh (8 cm by 12 cm in size) is inserted through the 10-mm port, and with the use of graspers, the mesh is placed horizontally covering the inguinal wall from the midline of the pubis to lateral to the deep inguinal ring. The mesh is then anchored with laparoscopic tacks (Tacker, US Surgical) to Cooper's ligament to prevent any mesh migration. Tacking is avoided near the iliac vessels or laterally near the ilio-hypogastric nerve, the genitor-femoral nerve, and the lateral femoral-cutaneous nerve of thigh. Occasionally a large piece of mesh (10 cm by 15 cm) is used without anchoring. In all bilateral repairs, two separate pieces of mesh are placed and fixed. At the conclusion, the gas is released and the three wounds are closed with absorbable sutures or glue.



LAPAROSCOPIC VENTRAL HERNIA REPAIR

Incisional hernia is the most common complication after abdominal surgery and despite ongoing research in wound closure and reparative techniques, abdominal incisional hernia remains an unresolved problem. There have been few operative challenges more vexing in the history of surgery than the incisional hernia, especially because the outcome of incisional hernia may have major social and economic implications. In USA, the incisional hernia rate range each year from 3 to 20% with approximately 90,000 repairs annually.

In addition, controversy surrounds those factors postulated to predispose patients to this surgical outcome. Some recently developed technical options, both open and laparoscopic approach; reportedly decrease the rate of incisional hernia recurrence. Although 10% to 30% of patients undergoing laparotomy will develop an incisional hernia and subsequent conventional open repair often fails to adequately address this substantial problem. The recurrence rate for primary tissue repairs may approach the 35% range, which is higher than the primary occurrence rate; when repaired for recurrence, rates have been reported greater than 50%. Although the advent of prosthetic repair has significantly reduced the recurrence rate compared with that of primary suture repair, and it remains in the ranges of 10% to 24%.

Gradual decreases in recurrence rates have been realized over the last decade as minimally invasive techniques have been increasingly utilized. For example, in some series, the recurrence rate of initial incisional hernias has been reduced to 2% to 9%. Moreover, multiple studies demonstrate that laparoscopic repair of incisional hernia results in a short length of stay and quick return to normal activities. The recurrence rate after laparoscopic repair of a recurrent hernia ranges between 9% and 12%, which is an improvement when compared with recurrence rates of 20% after conventional repair with prosthetic material.

Clearly, the laparoscopic approach to repair of incisional hernia has significantly improved the management of this problem.



The risk of incisional hernia development and postoperative recurrence may be influenced by both **local** and **systemic factors**.

Systemic factors include obesity, diabetes, steroid use, benign prostatic hypertrophy, pulmonary disease, advanced age, and male gender. **Local factors** like the size of fascial defect, the type of incision, the method of fascial closure, the incidence of postoperative hematoma, and postoperative wound infection have been frequently involved as etiologic factors for the development of an incisional hernia. Fascial defect size is a major issue when contemplating repair; data strongly suggest that the greater the size of the fascial defect, the greater the risk of subsequent recurrence. Incisional hernias may be classified as small (< 5 cm), medium (5–10 cm), and large or giant (> 10 cm).

Most incisional hernias appear within the first 5 years after an operation, emphasizing the importance of long-term follow-up in studies evaluating the incidence of incisional hernias and recurrence rates. Patients typically present with a classic abdominal bulge emanating from an aspect of their surgical scar. It is important to note, especially in the obese patient, that it is often hard to discern the actual size of the fascial defect. Frequently, the size of the subcutaneous sac and associated contents (omentum, bowel, etc.) is rather large while the actual fascial defect is small.

Symptomatic and enlarging hernias require repair most frequently. The combination of a small fascial defect and a large hernia sac with incarcerated contents can lead to intestinal strangulation. These hernias should be repaired preemptively unless there are absolute prohibitive operative risks, in which case, management must be individualized. In addition to the above reasons, cosmetic concerns often prompt patients to seek surgical treatment.

The final success of the operation depends, in part, on active preparation by the patient and physician. Patients should be encouraged to reduce systemic risk factors for recurrences, especially obesity and smoking, even if it requires reasonable delay of the surgery.



The risk of complications and recurrences should be thoroughly discussed with the patient. Informed consent is very important. Seroma formation is the most common postoperative complication, and patients should be advised to expect this; the larger the subcutaneous defect caused by the hernia sac and contents, the larger the subsequent dead space and, therefore, the higher the chance of seroma formation. If extensive adhesiolysis is anticipated due to bowel incarceration or multiple previous operations, the colon should be prepped appropriately. The management of unexpected enterotomy during adhesiolysis and the timing and method of subsequent herniorrhaphy should be discussed with the patient.

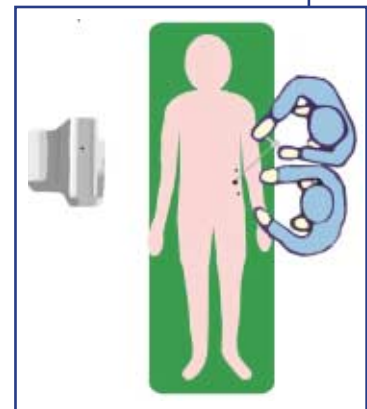
Preoperative preparation is important in the treatment of ventral hernias. All patients should receive a preoperative antibiotic, because wound infection is a major risk factor for recurrences. Preoperative pulmonary function should be evaluated and eventually physiotherapy should be initiated to further reduce postoperative morbidity. A DVT prophylaxis should also be considered.

Laparoscopic repair of large incisional hernias also utilizes totally intraperitoneal placement of mesh. Several studies have demonstrated that laparoscopic ventral herniorrhaphy is a safe and effective alternative to open techniques.

Patient and Trocars position's (see figure)

Operative Technique: For laparoscopic repair, the patient is placed in a supine position with both arms tucked by the side. Pneumoperitoneum is established using either a Veress needle or a Hasson trocar. The "open technique" using Hasson's trocar should be preferred.

It's also possible and useful to use a direct-view trocar (i.e. Opti-View) as first trocar instead of Hasson's trocar or Veress needle. The direct view trocar with 0 degree scope is very useful to avoid bowel injury accessing the abdomen. The first trocar is inserted laterally between the anterior iliac spine





and the subcostal margin (anterior axillary line). An angled [30° or 45°] laparoscope, inserted through the 10-12 mm trocar, must be utilized to facilitate the visualization of the the anterior abdominal wall. Once the first trocar is inserted, usually two, 5 mm trocars are placed under vision and well lateral to the defect, on either side of the 10-12 mm port (see figure).



Trocars placed too close to the edge of the defect may not allow adequate working space. Trocars placed too laterally may limit the downward displacement of the instrument handle.

If necessary, adhesiolysis is first performed to clear the margins of the defect and to avoid bowel injury, the use of diathermy or the ultrasonic dissector should be very careful. After adhesiolysis is performed a reduction of hernia contents is started with steady hand-over-hand withdrawal of the sac contents.

External counter-traction applied by the assistant may facilitate reduction of the hernia sac contents and can lower the abdominal “ceiling” to provide better working space. Once the margins of the hernia are well delineated and cleared, the defect can be measured by external palpation or with an intra-abdominal ruler.

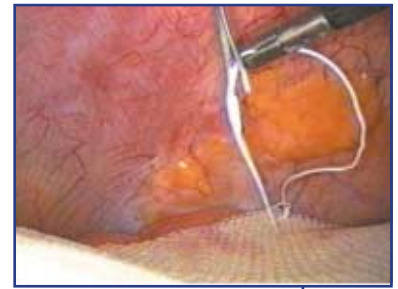


At the moment, few types of mesh are available on the market: gore-tex and PTFE (dual mesh or dual mesh plus), polyester or polypropylene coated with different antiadhesive agents. All the mesh comes in different size and dimension. A prosthetic mesh is then tailored to ensure a 3- to 5-cm overlap of all defect margins. Distinct “orienting” marks are placed on the mesh and on the skin, respectively, to assist with intra-abdominal orientation. Sutures are placed at four cardinal points of the mesh. For larger prosthesis, additional sutures may be placed between these four sutures. The mesh is then wrapped around a laparoscopic grasper and inserted through the 12-mm trocar. Once inserted, the mesh



is unfurled and oriented correctly; the preplaced sutures are pulled trans-abdominally using a suture passer through the previously marked locations.

Sutures should not be tied until all sutures are pulled, so that the mesh may be adjusted if requested. If we need to readjust the mesh to better cover the hernia defect, the sutures can simply be pulled back into the abdomen and replaced. Additional sutures should be placed trans-abdominally to ensure suture fixation every 3-5 cm. In order to prevent herniation of bowel between the mesh and the abdominal wall, anchor or spiral tacks are placed circumferentially along its peripheral margins every 3-5 cm. In case of large defect a second ring of tacks should be placed inside the first one.



CLINICAL RESULTS

Since its introduction in 1992, the laparoscopic approach has achieved better outcomes than have the historical conventional approach. Patients gain the routine benefits associated with laparoscopy, such as less pain, shorter length of hospital stay, and less blood loss. In various case series, the length of stay in the hospital ranges between 1 and 3 days. Some studies show that the operating time for laparoscopic repair is less than the conventional repair by as much as 30 to 40 minutes. Importantly, the recurrence rate is reduced significantly by 2% to 9%. Based on our experience and on the literature, we strongly recommend mesh overlap over the defect (3-5 cm) and fixation using suture and staplers,. In fact LeBlanc et al found recurrences were associated with a lack of suture fixation of a prosthetic overlap less than 3 cm. In a large, multicenter laparoscopic series of 407 patients (Todd Heniford, 1998), most recurrences (43%) occurred in patients whose mesh was fixated with staples and tacks only. Enterotomies should be managed by immediate repair of the enterotomy and delayed definitive repair of the hernia for 1 or 2 months, in order to avoid infecting the prosthetic patch. Extensive adhesiolysis increases the risk of prolonged ileus, another possible complication that may lengthen the hospital stay.



CONCLUSIONS

The laparoscopic approach is justified due to different and some important advantages compared to open surgery:

1. it avoids aggression to the abdominal wall by laparotomy;
2. it avoids unnecessary extensive dissection;
3. it eliminate the need for placing new under tension sutures over the abdominal wall;
4. it avoids the necessity of drainage;
5. the postoperative mobilization is faster;
6. the hospital stay shorter;
7. Wound sepsis and infection are less than in open surgery.

Moreover, the laparoscopic approach provide also some benefits like a complete exploration of the abdominal cavity, making the parietal and visceral adhesiolysis easier, which is very important in preventing chronic post-operative abdominal pain linked to the open procedures.





SUGGESTED READINGS

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